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FNAS/Rapid Spectral Inversion Methods

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Purpose

The purpose of this investigation is to study methods and ways for rapid inversion programs involving the correlated k-method, and to study the infrared observations of Saturn from the Cassini orbiter.

Background

The earth's and the planetary atmospheres consist of mixture of gases which emit radiation in the infrared spectral region, providing wealth of information about chemical and physical processes in the atmosphere. The atmospheric molecular constituents absorb and radiate by vibrational and rotational transitions, and the observed spectra exhibit characteristic spectral features in the region of the electromagnetic spectrum. The observed absorption or thermal emission spectra may be obtained with space-born high resolution infrared spectrometers the 50-1000 micrometers spectral region. A detailed analysis of the observed spectra leads to information about the atmospheric thermal structure, composistion, and the physical and chemical processes. The analytic techniques involve the development of radiative transfer models for calculation of the observed radiance and transmittances for realistic atmospheric conditions and observatinal geometries, and the development of inversion methods for retrieval of atmospheric parameters from the observations.

A capability for analysis and interpretation of infrared emissions and absorption measurements is being developed at the marshal Space Flight Center by modification of

the existing programs for applications to the currently operating or planned mission for ground-based and space-born observations. These missions include infrared observations of Saturn and Titan with CIRS instrument on the Cassini orbiter, and ATMOS solar calculation limb observations of the earth's atmosphere from the Shuttle platform.

Accomplishments

The radiative transfer models and inversion methods employed at the Marshall Space Flight Center for interpretation of the data have been extensively modified and updated to remove several deficiencies in the calculations, and to incorporate some important atmospheric processes that have not been considered so far.

The following additional work was accomplished:

1) In particular the software was improved to analyze the toxic gases O3, CO2, H2O and HO2.
2) The software was improve for investigating Saturn's atmosphere as it was observed by Voyager and specifically the gases CH4, NH3, C2H6.
3) The software was further improved to retrieve pressure-temperature profiles from infrared solar absorption spectra.
4) To the software infrared radiative transfer models for planetary atmospheres were incorporated. Attention was paid to the development of atmospheric standards for observations of astronomical sources from the infrared space observatory(ISO).
5) Inversion programs for simultaneous retrieval temperature and pressure from infrared observations in solar occultation mode were developed. A particular concern in the

developing techniques/algorithms was the unique determination of temperature and pressure at tangent height in limb viewing geometries. The existing iterative programs were found to have large oscillations in the retrieved temperatures and pressures. Various stabilizing techniques schemes were introduced and experimented with synthetic data superimposed with expected noise in realistic observed data. The developed techniques have been used on the infrared data obtained by the ATMOS instrument flown on NASA's ATLAS-I and II and shattle mission.

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